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NATIONAL DAM SAFETY PROGRAM. MOUNTAIN LAKE DAM (MO 30044) LOWER--ETC(U)
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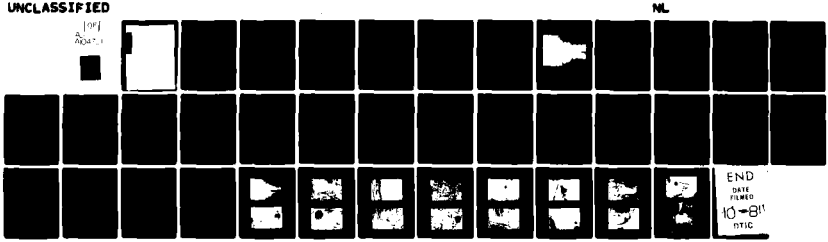

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MOUNTAIN LAKE DAM
WAYNE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30044

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: ST. LOUIS DISTRICT CORPS OF ENGINEERS
FOR: GOVERNOR OF MISSOURI

AUGUST 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Mountain Lake Dam
State Located	Missouri
County Located	Wayne County
Stream	Unnamed tributary to Rings Creek
Date of Inspection	11 July 1978

Mountain Lake Dam was inspected by an interdisciplinary team of engineers from the Memphis District, U. S. Army Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten the life and property of approximately 5 families downstream of the dam.

The inspection and evaluation indicate that the spillway does not meet the criteria set forth in the guidelines for a dam having the above mentioned size classification and hazard potential. According to the guidelines, the spillway is required to pass the Probable Maximum Flood (PMF) without the dam embankment being overtopped. The spillway will only pass 5 percent of the PMF before the dam embankment is overtopped. Because the spillway will not pass one-half of the PMF without overtopping, the dam is classified as "unsafe Non-emergency". The spillway will not pass the 100-year flood without overtoppping, which is a flood that has a 1 percent chance of being exceeded in any given year.

Other deficiencies visually observed by the inspection team were trees and bushes next to the concrete core wall, in and adjacent to the principal spillway, and on the downstream embankment slope; erosion gullies on the downstream embankment slope; and seepage. Another deficiency found was the lack of seepage and stability analysis records.

It is recommended that the owner take action to correct or control the deficiencies described. Corrective works should be in accordance with analyses and design performed by an engineer experienced in the design and construction of dams.

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SUBMITTED BY: SIGNED — 22 SEP 1978
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 22 SEP 1978
Colonel, CE, District Engineer — Date

Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
MOUNTAIN LAKE DAM - ID NO. 30044

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF PLATES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Mountain Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth embankment with a 12-inch wide, reinforced concrete core which protrudes approximately 2.5 feet above the crown of the earth embankment. The dam is built in a valley in the uplands which border the Mississippi Embayment. Topography adjacent to the valley is rolling to steep. Soils in the area are formed of red silty clays with fragments of dolomite and chert. Topography in the vicinity of the dam is shown on Plate 2.

(2) The principal spillway is located in the left abutment and consists of a "V" shaped, concrete weir and approximately 30 feet of paved channel. An emergency spillway is cut in the right abutment. The crown of the emergency spillway is covered with a 12-foot wide concrete pad. The remainder of the emergency spillway is grass covered earth. A 2-foot diameter concrete pipe exits downstream of the dam embankment and is connected to a valve controlled lake drain.

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the northwestern portion of Wayne County, Missouri, as shown on Plate 1. The lake formed by the dam is shown on the Patterson, Missouri Quadrangle sheet in Sections 15 and 22; Township 29 North; Range 4 East.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1 c above. Based on these criteria, this dam and impoundment is in the small size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification.

e. Ownership. This dam is owned by the Mountain Lake Hunting and Fishing League of Piedmont, Missouri 63957.

f. Purpose of Dam. The dam forms a 19-acre recreational lake.

g. Design and Construction History. The dam was reportedly constructed in 1927 by a land development company. The dam was originally planned to extend 7 feet higher, but because of financial difficulties the owners could not complete the structure. In 1964 the principal spillway was raised approximately 0.5 feet by adding a concrete cap on top of the weir.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relative stable water surface elevation. The dam was reportedly overtopped at least three times since the 1950's. A lake drain is utilized for drawing down the lake level during the winter months for biological maintenance of the lake.

1.3 PERTINENT DATA

a. Drainage Area - 1200 acres (1973 inventory).
1220 acres (Topographic Quadrangle).

b. Discharge at Damsite.

(1) Discharge can take place both through the principal spillway and the emergency spillway.

(2) Estimated experienced maximum flood at the damsite- unknown.

(3) Estimated ungated spillway capacities at maximum pool elevation - 509 cfs.

c. Elevation (Feet above M. S. L.)

(1) Top of dam - 546.0 ± (See Plate 3).

(2) Crest of Principal Spillway - 544.3±.

(3) Crest of Emergency Spillway - 544.6±.

(4) Streambed at centerline of dam - 522± (Extrapolation from survey).

(5) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 1400± feet (USGS Quad Map.)

e. Storage (Acre-feet).

(1) Maximum - 150 (1973 inventory).
150 (USGS Quad Map, Survey and 114 acre-feet as normal storage).

(2) Normal - 114 (1973 inventory).

f. Reservoir Surface (Acres).

(1) Top of dam - 22.7±

(2) Spillway crest - 18.9±

g. Dam.

(1) Type - earth embankment, with concrete core extending 2.5 feet above embankment crown.

(2) Length - 950± feet.

(3) Height - 24 feet maximum.

(4) Top width - 12± feet.

(5) Side slopes -

(a) Downstream - 1V on 1.7H (Average).

(b) Upstream - 1V on 3.0H (Average).

(6) Zoning - unknown.

(7) Impervious core - concrete core.

(8) Cutoff - unknown.

(9) Grout curtain - unknown.

h. Diversion and Regulating Tunnel. None.

i. Principal Spillway.

(1) Type - An uncontrolled concrete weir.

(2) Width of weir - 33.6 feet.

(3) Crest elevation - 544.3 feet m.s.l.

j. Emergency Spillway.

(1) Type - Uncontrolled earth with 12-foot wide concrete pad over the crown.

(2) Width of weir - 25 feet (Botton width).

(3) Crest elevation - 544.6± feet m.s.l.

k. Regulating Outlet.

(1) Type - valve controlled.

(2) Length of pipe - unknown.

(3) Invert of pipe in lake - unknown.

(4) Discharge Invert - 526.7 feet m.s.l.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data are known to exist.

2.2 CONSTRUCTION

The dam was reportedly constructed in 1927 by a land development company. The dam was originally planned to extend 7 feet higher, but because of financial difficulties the owners could not complete the structure. In 1964 the principal spillway was raised approximately 0.5 feet by adding a concrete cap on top of the weir.

2.3 OPERATION

The dam was reportedly overtopped at least three times since the 1950's. A lake drain is utilized for drawing down the lake level during the winter months for biological maintenance of the lake.

Some silty deposits in the back of the lake were reportedly removed several years ago.

2.4 EVALUATION

a. Availability. The only engineering data readily available are the personal recollections of the League members.

b. Adequacy. The field and visual inspections presented herein are considered adequate to support the conclusions of this report. **Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.**

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. Visual inspection of Mountain Lake Dam was performed on 11 July 1978. Personnel making the inspection were employees of the Memphis District, Corps of Engineers, and included a geologist, hydraulic engineer, and soils engineer. Also a League member accompanied the inspection team. Specific observations are discussed below.

b. Project Geology. As the dam was constructed from local materials it probably consists of red silty clay with dolomite and chert fragments intermixed. The red clay is the result of weathering of the underlying dolomite. The soil represents the Recent which lies unconformally on the Eminence formation of the Cambrian. The eminence consists of a tan to light brown, fine to medium grained, massively bedded, moderately hard calcarous dolomite. The dam is located in a Seismic Zone 2.

c. Dam. A 12-foot wide gravel road runs on top of the embankment crown for the length of the dam (see Photo 3). On the upstream side of the embankment crown a 12-inch wide, reinforced concrete core is located and it extends the length of the dam (see Photo 4). The depth of the core is unknown. The core protrudes approximately 2.5 feet above the embankment crown thereby forming a wall. Vertical reinforcing bars which are 2 inches wide and 1/2 an inch thick (see Photo 6) extend 2-3 feet above the core and are spaced 2 feet apart. Also stones approximately 8 inches in diameter are set into the top of the core. The stones and the exposed reinforcing bars were to facilitate a seven foot addition to the wall as discussed in paragraph 2.2. Vertical cracks approximately 1/8 of an inch wide, extending from the ground surface to the top of the core are located in the core about every 10 feet. The majority of the cracks have been patched. It is not known whether or not these cracks extend below the ground surface.

Trees and bushes are growing on the lake side of the core wall (see Photo 5). The upstream embankment has an average slope of 1V on 3H based on the cross-section presented on Plates 4 and 5. The downstream embankment slope is very steep (1V on 1.7H average slope) and overgrown with trees (see Photos 7 and 9), and also the slope has numerous erosion gullies (see Photo 8) which were developed when the core wall was overtopped by the lake.

Light seepage was observed in three areas downstream of the embankment. Two of the areas were approximately 50 feet long and 10 feet wide located at baseline stations 6+00 ± and 3+50 ± about 10 feet from the downstream toe of the embankment. The other area of seepage is adjacent to the downstream embankment toe between baseline stations 2+00 and 3+00. Approximately 5 gpm was flowing from this area (see Photo 10).

d. Appurtenant Structures. The principal spillway is located in the left abutment and consists of a "V" shaped, concrete weir and approximately 30 feet of paved channel (see Photos 11 and 13). A concrete bridge crosses the spillway as shown in Photo 12. Small trees are growing in cracks in the spillway paving and adjacent to the paving.

An emergency spillway is cut in the right abutment. The crown of the spillway is covered with a 12-foot wide concrete pad and the remainder of the spillway is grass covered earth (see Photo 15).

A valve controlled lake drain is connected to a 2-foot diameter, concrete discharge pipe (see Photo 16). Because of the unaccessible location of the drain, it could not be inspected. Reportedly the lake level is lowered every winter by the lake drain.

e. Reservoir Area. No wave wash, excessive erosion of slides were observed along the shore of the reservoir.

f. Downstream Channel. The downstream channel parallels the dam embankment for approximately 500 feet and then angles away from the dam. As shown on Plates 4 and 5, the channel is located approximately 60 feet from the embankment toe. The channel is in good condition and is not overgrown with vegetation (see Photo 14).

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action or a serious potential of failure. Visually observed seepage; vegetation on the downstream slope, adjacent to the concrete core wall, and in and adjacent to the principal spillway; erosion gullies on the downstream slope are deficiencies which, left uncontrolled or uncorrected, could lead to the development of potential problems.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The primary and emergency spillways are uncontrolled; therefore, no regulating procedures exist for these structures. The valve controlled lake drain is utilized every winter to draw down the lake level for biological lake maintenance.

4.2 MAINTENANCE OF DAM

Little maintenance is apparent as evidenced by the vegetative cover and erosion gullies on the downstream slope. Brush and small trees are growing through and near the principal spillway and adjacent to the core wall.

4.3 MAINTENANCE OF OPERATING FACILITIES

No information is available concerning maintenance of the lake drain.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

If the uncontrolled vegetation on the downstream slope, in and near the principal spillway, and adjacent to the core wall; and erosion on the downstream slope are allowed to continue, potential problems could develop.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data are available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Patterson, Missouri Quadrangle. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations.

(1) The principal and emergency spillways and the exit channels are in good condition.

(2) Small trees and bushes are growing in and adjacent to the principal spillway.

(3) The principal spillway and emergency spillways are located respectively on the left and right abutments.

(4) The valve controlled lake drain could not be inspected because of the unaccessible location.

Overtopping Potential. The spillway will pass 5 percent of the Probable Maximum Flood (PMF), without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region. For its size and hazard category, this dam is required by the guidelines to pass from one-half PMF to PMF. However, considering the high hazard potential to life and property of approximately 5 families downstream of the dam, the spillway size and/or height of dam should be increased to pass the PMF, without overtopping the dam. Because the spillway will not pass one-half of the PMF without overtopping, the dam is classified as "unsafe Non-emergency". The spillway will not pass the 100-year flood without overtopping, which is a flood that has a one percent chance of being exceeded in any given year.

The effect from rupture of the dam could extend approximately 2 miles downstream of the dam. There are approximately 5 inhabited homes downstream of the dam which could be severely damaged and lives of inhabitants could be lost should failure of the dam occur.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of the dam and appurtenant structures are discussed and evaluated in SECTIONS 3 and 5. The very steep downstream slope (1V on 1.7H) and the observed seepage areas at the base of this slope raise concern for the continued stability of the dam. These conditions indicate that the stability safety factor of the downstream slope may be extremely low when compared to the suggested safety factors presented in the "Recommended Guidelines for Safety Inspection of Dams", and that a potential for internal piping of embankment and foundation material exists.

b. Design and Construction Data. The design and construction data were limited to that information discussed in SECTION 2.

c. Operation Records. There have been no known operations which have affected the structural stability of the dam.

d. Post Construction Changes. No post construction changes, other than those referenced in paragraph a above, exist which will affect the structural stability of the dam.

e. Seismic Stability. This dam is located in Seismic Zone 2. However, it is located very near the boundary between Seismic Zones 2 and 3. Since this dam is located in Seismic Zone 2 and the proximity of Seismic Zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items were noted during the visual inspection which should be corrected or controlled. These items are trees and bushes next to the concrete core wall, in and adjacent to the principal spillway, and on the downstream embankment slope; erosion gullies on the downstream embankment slope; a very steep downstream slope; and observed seepage. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. Also these analyses should be utilized to detail the corrective actions called for in paragraph 7.2. The Probable Maximum Flood (the design flood) and one-half of the Probable Maximum Flood will both overtop the dam.

b. Adequacy of Information. Due to the lack of engineering design and construction data, the conclusions in this report were based on performance history and external visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein.

c. Urgency. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The stability and seepage analyses should be given priority by the owner and accomplished without delay in order to determine if corrective measures are necessary. If the safety deficiencies listed in paragraph 7.1a are not corrected in a timely manner, they could lead to the development of potential problems.

d. Necessity for Phase II. Based on the results of the Phase I inspection, no Phase II inspection is recommended.

e. Seismic Stability. This dam is located in Seismic Zone 2. However, it is located very near the boundary between Seismic Zones 2 and 3. Since this dam is located in Seismic Zone 2 and the proximity of Seismic Zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the dam.

7.2 REMEDIAL MEASURES

a. Alternatives. Spillway size and/or height of dam should be increased to pass the Probable Maximum Flood without overtopping the dam.

b. Perform seepage and stability analyses to assess the safety concerns raised by the seepage present at the toe of the downstream slope and the steep downstream slope. Use the results of these analyses to design appropriate corrective measures.

c. O & M Maintenance and Procedures. The following O & M maintenance and procedures are recommended:

(1) Remove trees and bushes adjacent to the concrete core wall, in and adjacent to the principal spillway, and on the downstream embankment slope. Care should be taken during removal not to destroy the existing conditions of the concrete core wall, the principal spillway, and the downstream slope.

(2) Establish and maintain a grass cover on the embankment slope.

(3) Repair the downstream slope where gullies have formed.

(4) The downstream slope and toe should be closely monitored for seepage and erosion. If seepage quantities and/or erosion observed during monitoring indicate increases or signs of material being piped from the embankment, immediate action should be taken to rectify these conditions.

(5) A detailed inspection of the dam should be made at least every 5 years by an engineer experienced in design and construction of dams.

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. HEC-1 was used to develop the inflow hydrograph for PMF and hydrologic characteristic of drainage basin.

2. HEC-1 uses Snyder Method for developing synthetic unit hydrographs with Clarks Modification.

Final Variables

Drainage Area	1.91 sq. mi.
Travel Time of Runoff	60 min.
Initial Loss of Rainfall	0.5 in.
Average Loss Rate	0.05 in./hr.
C_t	0.72
C_p	0.594
PMF Rainfall	**26.9 in.**
PMF Percentages	**6 hr. 102**
	12 hr. 120
	24 hr. 130

3. The inflow hydrograph was routed through the reservoir using HEC-1's modified Puls option. Releases were calculated for both the principal spillway and the emergency spillway. The broad-crested weir equation was used **to calculate spillway discharges.**

Principal Spillway

C = 3.1
L = 33.6

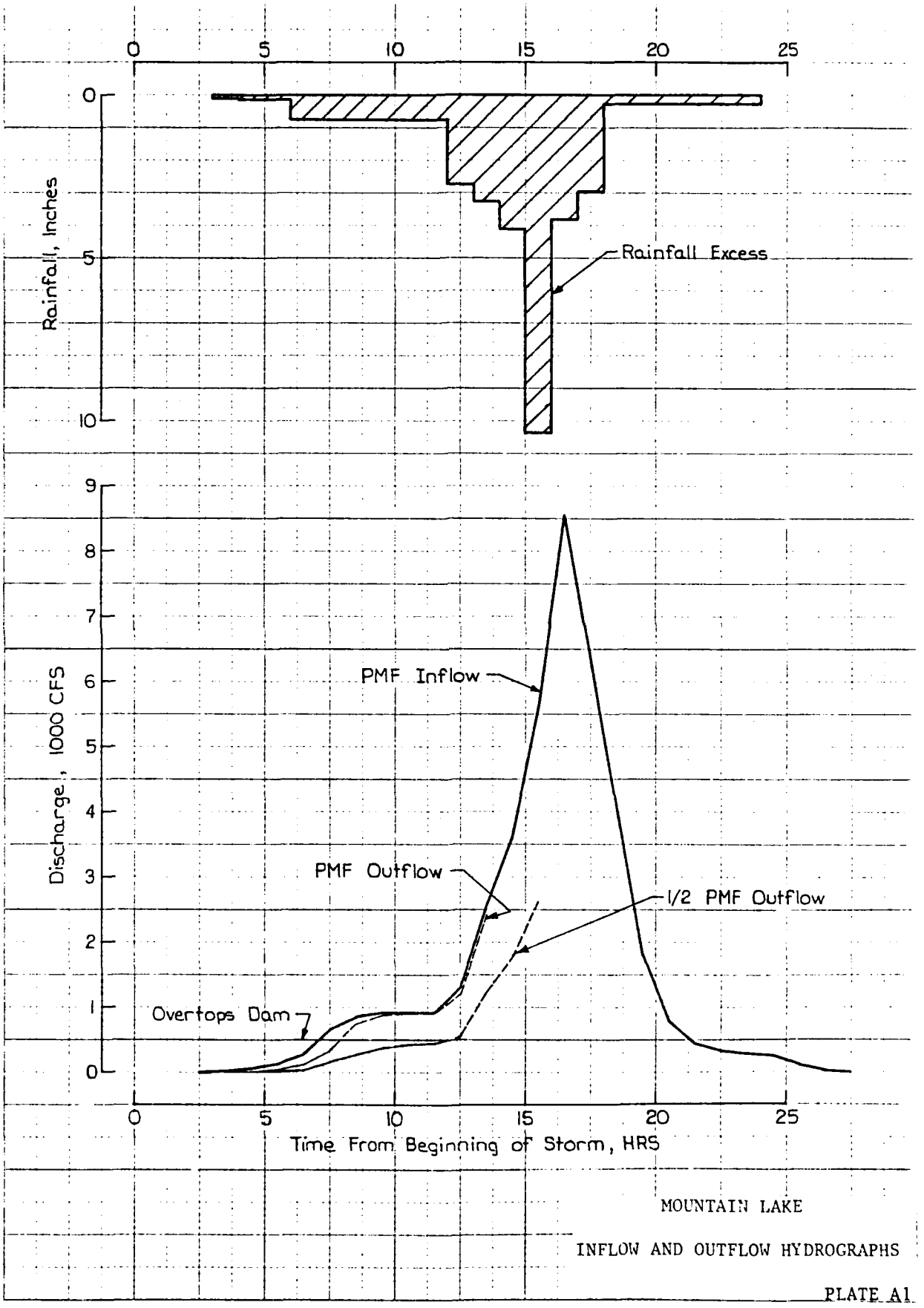
Emergency Spillway

C = 2.8
L = Based on elevation

Top of Dam

C = 2.8
L = 950

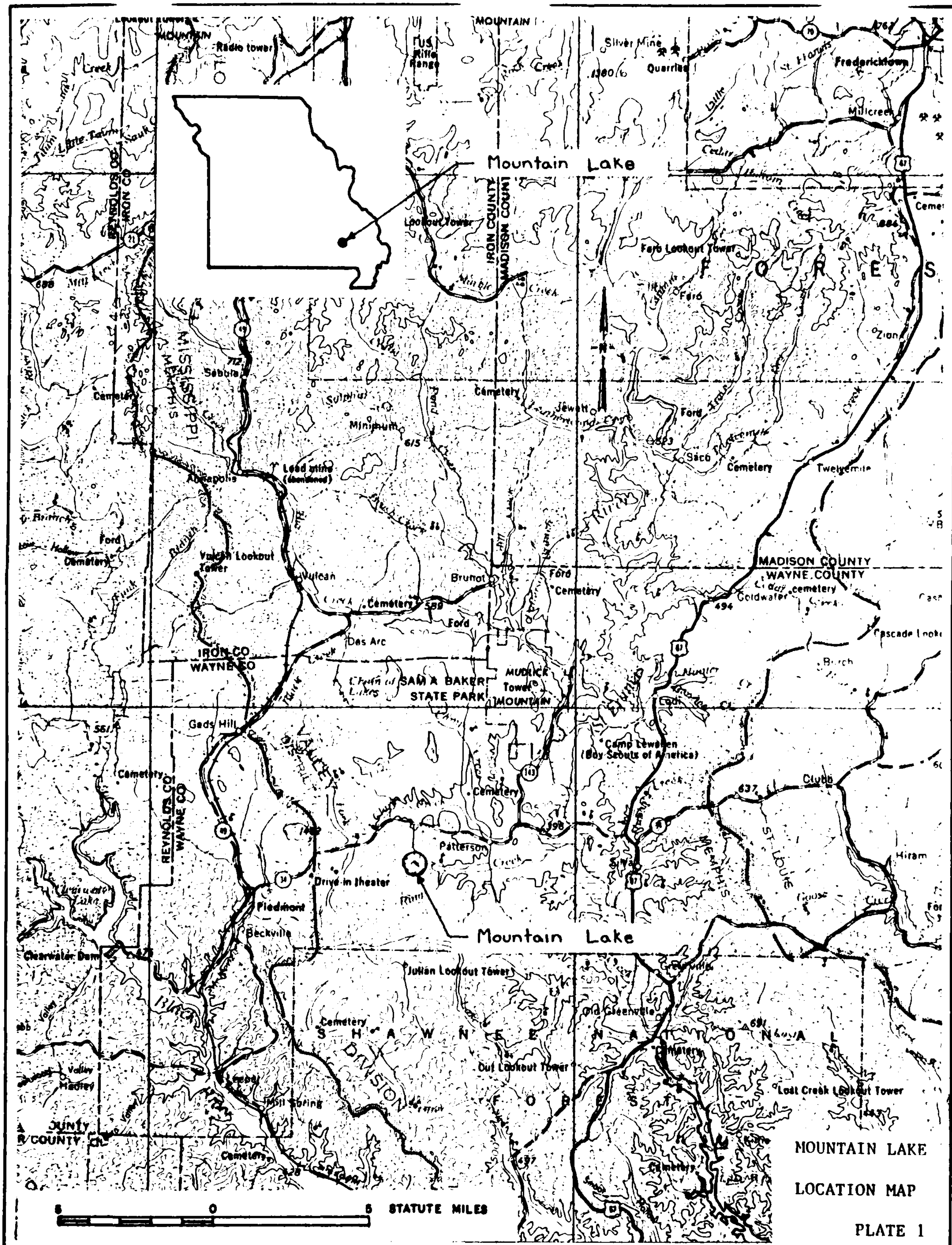
4. PMF rainfall distribution, inflow hydrograph, and outflow hydrograph are shown on Plate A1.



MOUNTAIN LAKE

INFLOW AND OUTFLOW HYDROGRAPHS

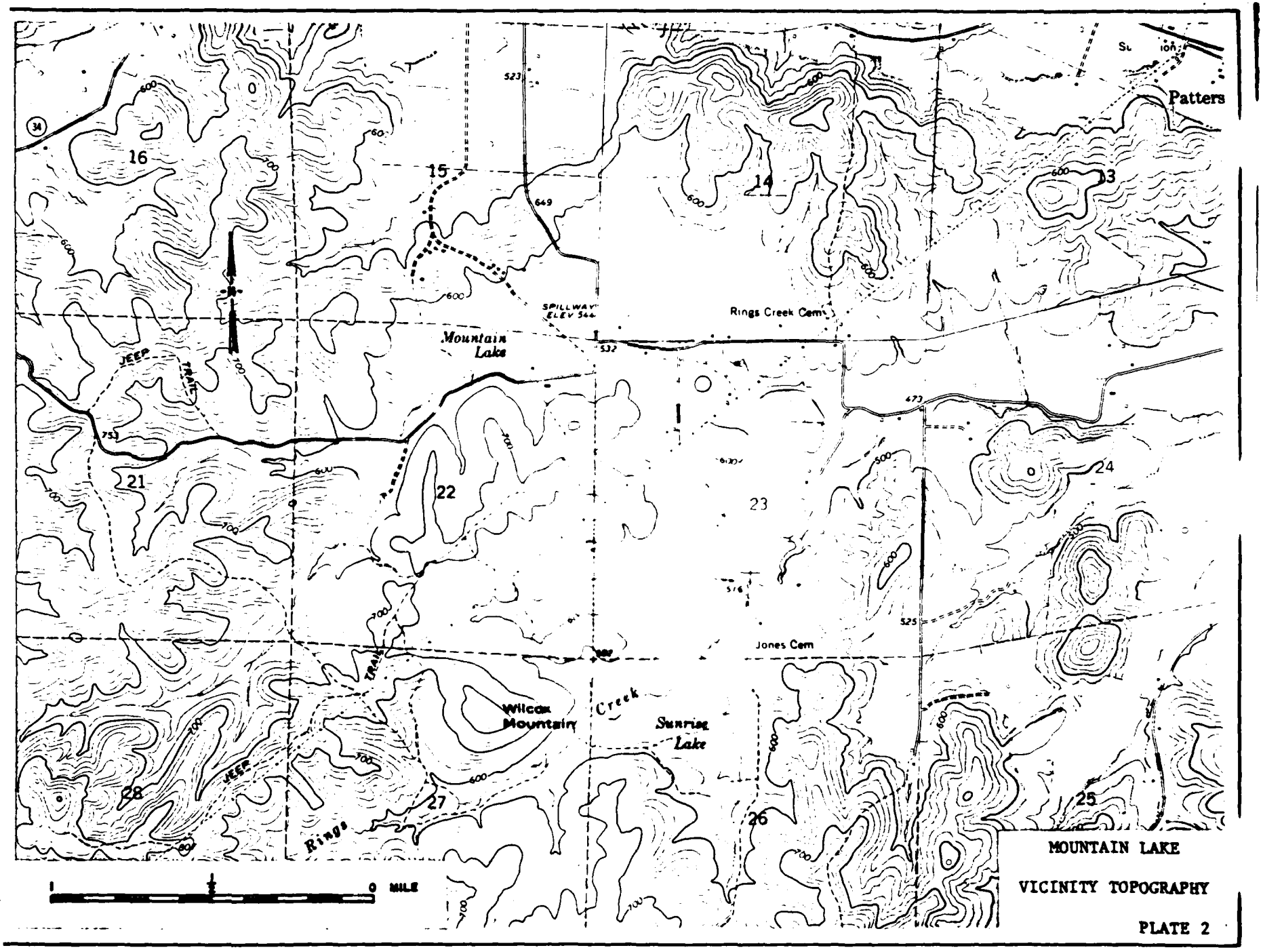
PLATE A1



MOUNTAIN LAKE

LOCATION MAP

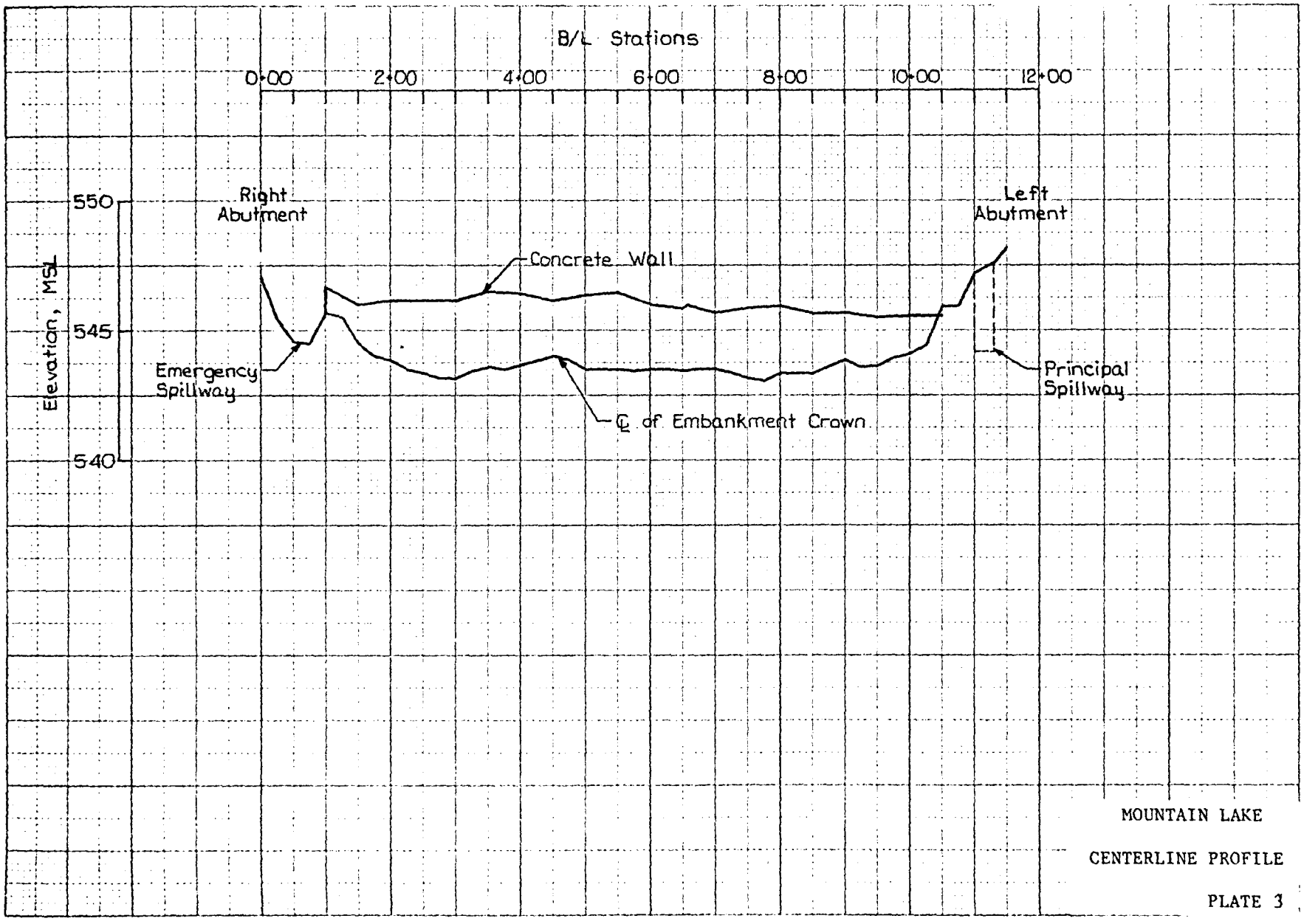
PLATE 1



MOUNTAIN LAKE

VICINITY TOPOGRAPHY

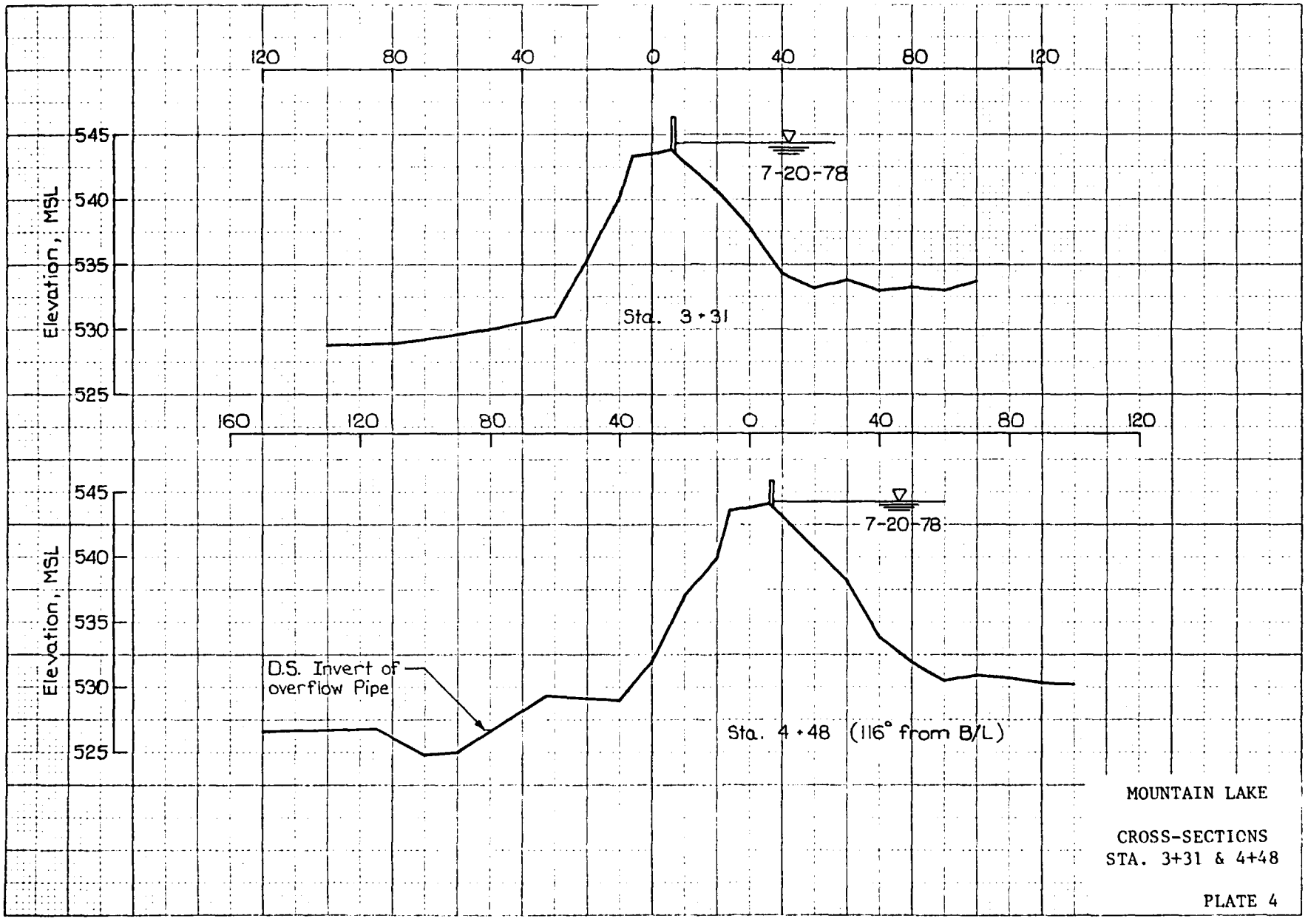
PLATE 2



MOUNTAIN LAKE

CENTERLINE PROFILE

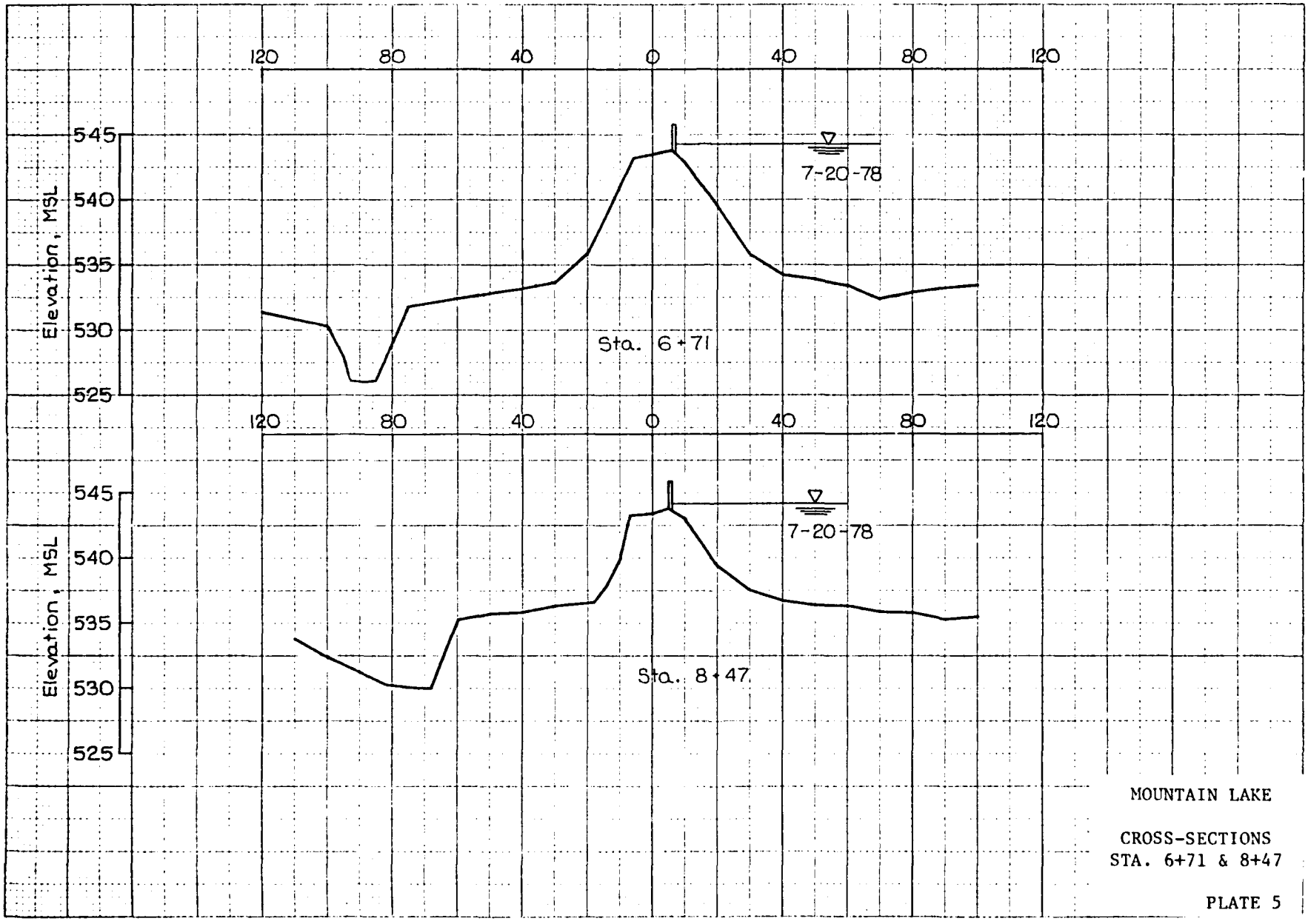
PLATE 3



MOUNTAIN LAKE

CROSS-SECTIONS
STA. 3+31 & 4+48

PLATE 4



MOUNTAIN LAKE

CROSS-SECTIONS
STA. 6+71 & 8+47

PLATE 5

PHOTO 1: Overview of Lake and Dam

PHOTO 2: Crown of Dam

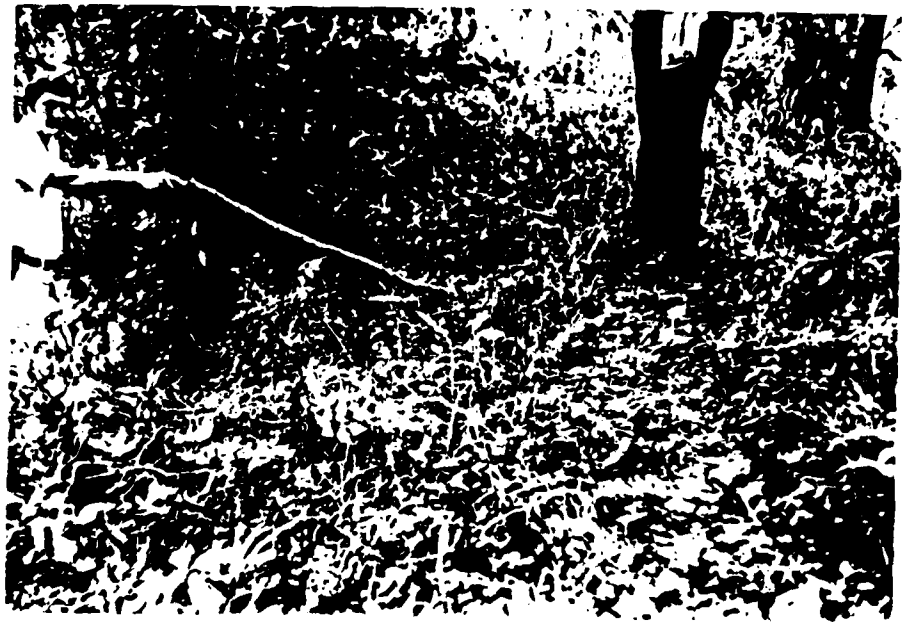


PHOTO 3: Erosion Gully on Crown of Dam

PHOTO 4: Animal Burrow on Crown of Dam

PHOTO 5: Downstream Slope

PHOTO 6: Downstream Slope

PHOTO 7: Saturated Area on Downstream Slope

PHOTO 8: Saturated Area on Downstream Slope

PHOTO 9: Left Abutment Seepage

PHOTO 10: Spillway - Left to Right View

PHOTO 11: Spillway - Right to Left View

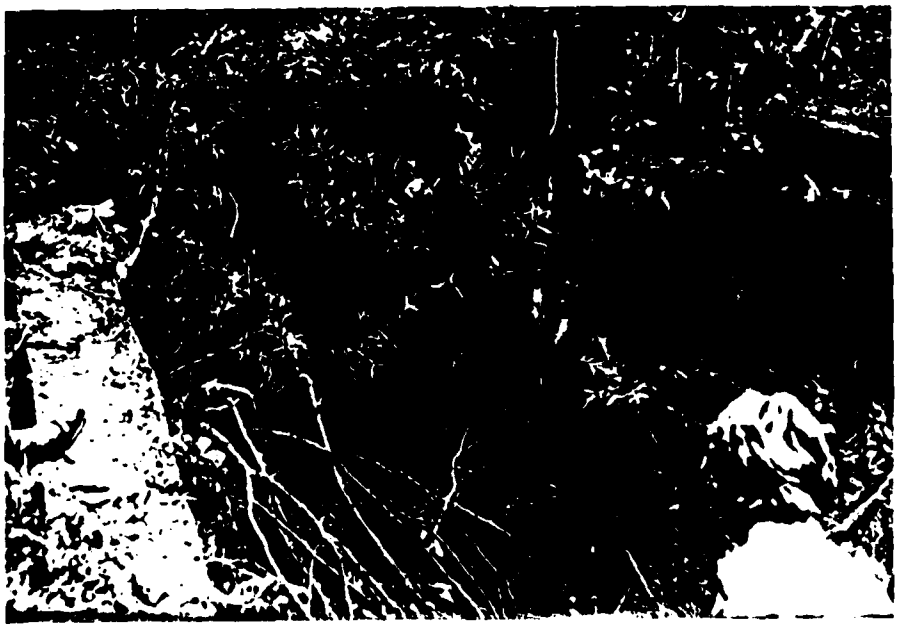


PHOTO 12: Spillway - Downstream View

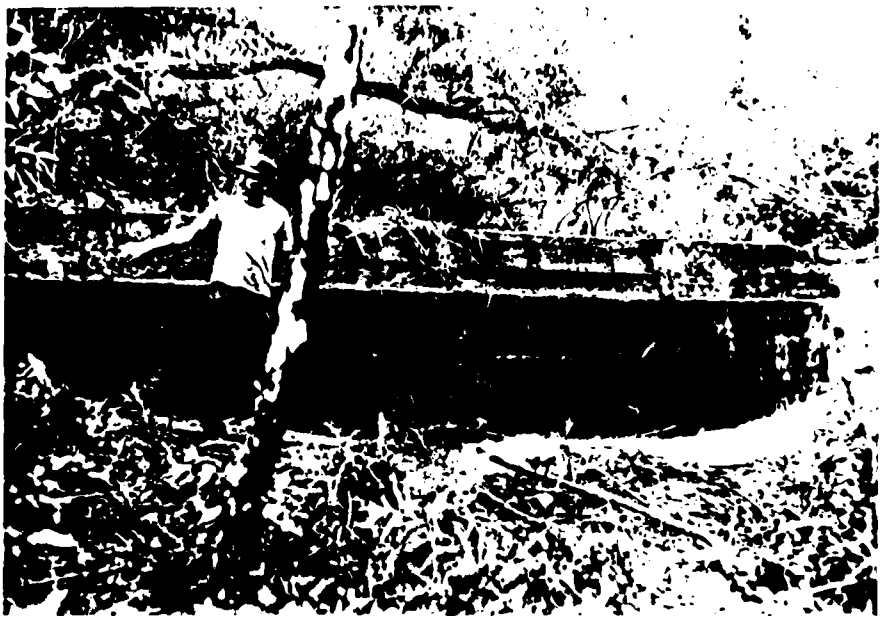


PHOTO 13: Spillway - Upstream View

PHOTO 14: Spillway - Upstream View

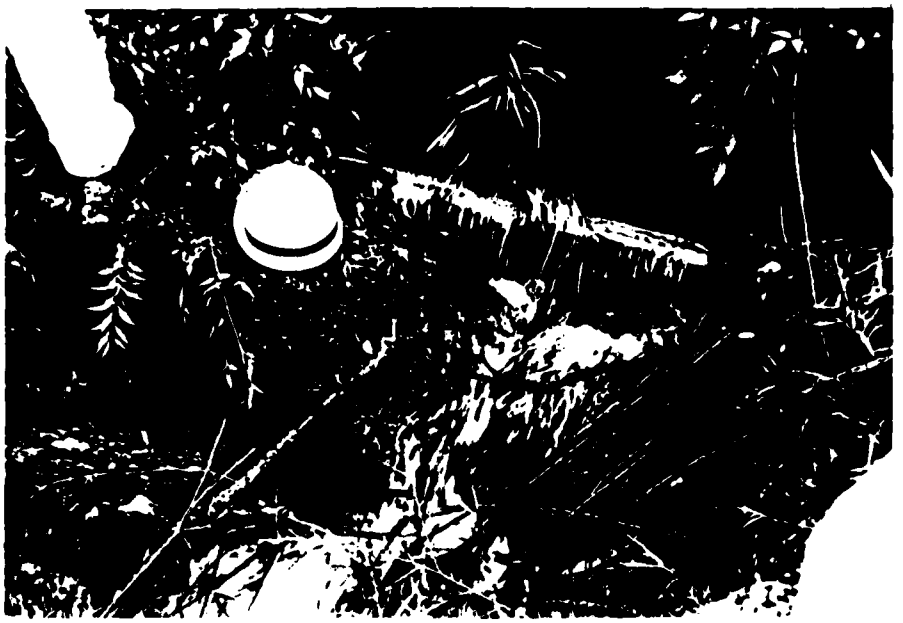
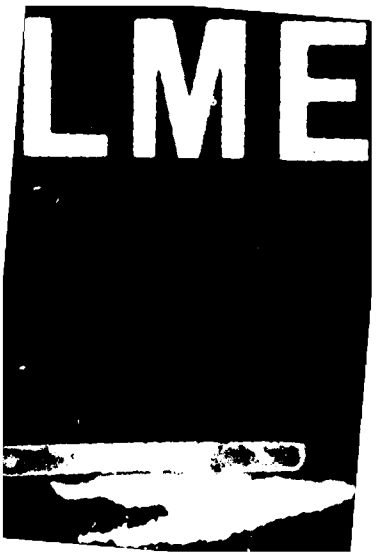


PHOTO 15: Notch in Spillway Weir

PHOTO 16: Valve Controlled Lake Drain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